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Blood serum uric acid and cholesterol levels in the blood were studied in relation to inner drive and external pressures of college students in the U.S.A. and in Sweden. Subjects for the study included 210 American and 78 Swedish male and female college students and 138 college football players. The blood chemicals were measured by Technicon analyzers. The Scholastic Aptitude Test measured the academic ability of the American students, and high school grade point average with that of the Swedes. The findings show evidence of a positive relationship between inner desire to achieve and serum uric acid level, and between external environmental pressures and cholesterol level. Among students in a highly competitive American college, a significant correlation was found to exist between students' serum uric acid levels and their grade point averages. This finding was not observed in Sweden where admission is more selective and academic pressures are less. Intercollegiate football players had higher serum uric acid and cholesterol levels during football season than in Spring training. Male science majors also had higher serum chemical levels than those with other college majors. (Author/JS)

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FURTHER RELATIONSHIPS BETWEEN BLOOD CHEMICAL VALUES AND COLLEGE STUDENT PERFORMANCE AND ATTITUDES

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Introduction

The research reported here grew out of earlier studies of relationships between college achievement and a number of non-cognitive characteristics of students at Wagner College in New York City, a coeducational Lutheran college of about 2400 students. The results of those studies have been presented in some detail by Gordon, Lindeman and Gordon (1967) and will not be described fully in this report.

Among the findings of the Wagner studies was the fact that relationships existed between achievement as measured by grade-point-average (GPA) and blood serum uric acid (SUA) levels in both males and female student nurses. This observation confirmed those of Dunn et al (1963), Brooks and Mueller (1966), and Kasl, Brooks and Cobb (1966), all of whom found serum urate level positively associated with academic or occupational performance among males. Analyses of the Wagner data suggested that the relationship between SUA and GPA was modified by other characteristics of the individual, particularly by his personal inner drive and motivation and by his reactions to external pressure and the competitive nature of his environment. For example, senior students were found to have higher SUA levels than sophomores, possibly indicating that students with low SUA levels failed to complete their studies. Serum cholesterol levels seem to rise in response to external events that pressure the individual.

They are elevated in students at examination time, for example, especially when they feel overburdened. (Rahe, Rubin, Arthur & Clark, 1968).

In this present study further data will be reported on psychological and serum chemical studies of students at Wagner College, at the University of Stockholm and at the University of Florida. Interest in studying the relationships among Swedish students stemmed from the apparent connection between the expression of the individual's personal drive and motivation and the competitiveness and pressures of the college environment in which he is situated. We believe that the competitive environment which characterizes most American colleges tends to enhance the importance of the individual's inner drive as a factor in his achievement. Consequently we hypothesized that under the less stressful and competitive conditions in Swedish colleges the observed relationships between SUA and achievement would be less pronounced or non-existant. In order to look at another aspect of the competitive college scene, blood chemicals of the college football players at the University of Florida were studied during spring practice and during the Fall football season.

While our major concern in the Swedish research has centered on the SUA-achievement relationship, we were interested in several other questions as well. In the Wagner studies we found that smoking, coffee consumption, alcohol consumption and personal stress were all related to achieve-

ment. Insofar as these characteristics and habits are related to environmental stress and pressures the relationships among Swedish students might be somewhat different. We also observed that birth order and physical exercise were associated with achievement, SUA level and blood cholesterol level and wished to determine whether these same relationships would hold among the Swedish students. In the Wagner studies we observed significant positive relationships between SUA and cholesterol among low ability students but not among those of relatively high ability. This relationship we also believed might be somewhat different among Swedish students due to reduced stress in their academic environment.

We also observed among the Wagner students significant differences in interpersonal manipulative attitudes (Michiavellianism[1]) between sophomore, junior and senior classes. Sophomores had the highest mean scores on this variable and seniors the lowest. Sophomores, on the other hand, had the lowest mean SUA levels. These findings suggested that in achieving their academic goals senior students might depend more on inner drive and motivation and less on manipulative skills than sophomores. We wished to see whether similar differences could be observed among Swedish students.

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[1] Based on a paper-and-pencil attitude test developed by Professor Richard Christie, Columbia University. The scores yielded are Machiavellianism, Authoritarianism, Social Desirability and Anomie.

Method

Subjects. Subjects for the study consisted of 75 male and 135 female Wagner College students, 31 male and 47 female University of Stockholm students and 138 University of Florida male collegiate football players. At Wagner College all students were volunteers, while at the University of Florida the blood tests were obtained as part of the football players' compulsory periodic complete physical examinations. The participation of the Swedish subjects was on a semi-voluntary basis. All students in the psychology program in which they were enrolled are required to serve as subjects in experiments but had a choice of research projects in which to participate. The group represented over two-thirds of the total available.

Students' blood chemicals were measured by Technicon autoanalyzers. The Scholastic Aptitude Test (SAT) measured the academic ability of Wagner College students, and high school grade point average (HSGPA) that of the Swedes, since no standardized aptitude tests are routinely administered to Swedish students. While this measure was not entirely satisfactory because of variations in quality of high school instruction, it was judged to be useful in distinguishing between students of greater and lesser ability on a broad categorical basis. It was considered superior to the analogous United States measure because the general high school curriculum is common throughout Sweden. Grade point averages (GPA) on courses taken during the semester measured academic per-

formance.

Analyses consisted of zero-order correlations between continuous variables (i.e. blood chemical values, attitude scores and measured achievement) and of analyses of variance to detect relationships between certain discrete variables and the continuous variables. Primary use has been made of the Biomedical Computer Programs (1967) BMDO3D and BMDO5V for these purposes. Since sex differences have been consistently observed in previous analyses of data, analyses were done separately for males and females.

Results

In Table I the upward class gradient among Wagner College Students for SUA can be observed. This table also demonstrates that low ability freshmen and sophomores (SAT scores less than 500) tended to have higher SUA levels than their classmates with higher ability (SAT scores greater than 500). Apparently SUA level is positively associated with higher motivation and inner drive required to compete in college. Further support for this conclusion came from the fact that among higher ability Wagner College students there was a significant correlation between GPA and SUA and among females between cholesterol and GPA. (See Table 2) For low ability students no relationship was found between SUA and GPA. Among students who possess the requisite academic ability those with relatively more inner

drive and motivation (as reflected in SUA level) appear to be likely to achieve at a relatively higher level than those without these characteristics.

(Insert Tables 1 and 2 about here)

Looking now at Table 3 we can see that with Wagner College students of high academic ability (SAT > 500) there was an insignificant or negative correlation between SUA and cholesterol. This finding suggests that high ability (SAT > 500) students with inner drive were not externally pressured by their academic duties. Female students with low SAT's on the other hand, showed a significant correlation between SUA and cholesterol. Presumably highly motivated (high SUA) but low ability students were pressured (elevated cholesterol) by their studies, and vice versa. (See Table 3).

(Insert Table 3)

Comparing Wagner College students with different college majors in Table 4 we note signifant differences among SUA's and glucose levels among women. Male science majors had the highest SAT's, blood serum chemical levels, and GPA's, suggesting that among males combinations of high ability, inner drive, and responsiveness to external pressure are

required for success in studying science in college. (See Table 4).

(Insert Table 4)

With Swedish students correlation coefficients between achievement, HSGPA, certain blood chemical values, and the attitude measures are shown in Table 5 (females) and in Table 6 (males). Means and standard deviations of these variables are given in Table 7 for both sexes.

(Insert Tables 5, 6 & 7)

Inspection of Tables 5 and 6 reveals that the correlation between achievement and SUA is not significantly different from zero for either males ($r = -.12$) or females ($r = .02$). There is no evidence from the data to suggest the presence of a relationship between these variables. Thus, our hypothesis that no relationship would be found tends to be supported.

Tables 5 and 6 also show that there is no significant relationship between HSGPA and achievement in the psychology program in which the students were enrolled. This finding may be due in part to the fact that students in the program are highly selected and consequently have a relatively high mean and low variability on the HSGPA measure. If we assume that this is the case, then the sample may be considered

roughly analogous to higher ability U.S. students, among whom the SUA-achievement relationship was stronger than for lower ability students. The fact that no relationship was observed, even among apparently higher ability Swedish students lends further support to our hypothesis.

Another finding of interest concerns the significant positive relationships observed for both Swedish men ($r = .29$) and Swedish women ($r = .23$) and for Wagner College women between achievement and cholesterol level. In American student populations relationships between temporary stress (such as produced by examinations) and cholesterol level had previously been observed. Significantly higher cholesterol levels were observed in Swedish as compared with American students, and SUA level was significantly lower in Swedish than in American female students (See Table 8). While these differences might be explained in part by dietary factors, they may also be associated with differences in reaction to the academic environment in the two groups.

(Insert Table 8)

The relationships between the attitude measures and achievement were similar among Swedish and American students. The negative correlation ($-.32$, p less than $.05$) between social desirability and achievement among the Swedish male students suggests that the adoption of socially desirable

attitudes tends to be associated with poorer rather than with better achievement. The relationship for females, while in the same direction, is not significant. Also of interest in connection with these measures are the rather marked differences between means for the Swedish and American students. The results in Table 9 show that Swedish students tend to be less authoritarian and much more michiavellian than the students in the Wagner College Sample. They also exhibited a greater degree of anomic disenchantment and tended to be less conforming with socially desirable attitudes and behaviors. While these differences are due in part to differences in institutional size and character and to cultural factors, they probably also reflect differences in the social and governmental systems in the two countries. Further study of the data at hand and further investigation of other research findings in these areas would appear to be fruitful.

(Insert Table 9)

A number of additional analyses were carried out to determine whether there were relationships between certain biographical and personal characteristics of the Swedish students and achievement, SUA and cholesterol levels. The characteristics investigated were birth order, amount of physical exercise, smoking, alcohol consumption, coffee

consumption, car ownership, parental status, class level, and reaction to study pressures. Reported here are the results only of those analyses which yielded significant differences between groups classified on the basis of these biographical and personal characteristics.

Of major interest were relationships between these characteristics and general achievement. Contrary to findings with Wagner College students, no significant relationships were found between achievement and smoking, alcohol consumption, having a car at the University, ability to study better under examanation pressure or parental status (i.e. living together or not). Significant relationships were found between achievement and coffee consumption and amount of exercise. The data on coffee consumption shown in Table 10 show that this variable has a significant negative relationship to general achievement. The relationship is stronger for males but appears for both sexes. A similar relationship was found for Wagner College students. Concerning physical exercise, reference to Table 11 shows a significant interaction between this variable and sex. Physical exercise is positively related to achievement in females and negatively related in males. With Wagner College students similar results were obtained for females, but no relationship was found for males.

(Insert Tables 10 & 11)

Relationships between certain of the above characteristics and SUA and cholesterol levels were also investigated. Results differed from those with American students in that no significant relationships were found between SUA level and birth order, class level (first or second year), physical exercise, or alcohol consumption. Significant interactions were observed between sex and coffee consumption and smoking when SUA was used as the dependent variable. Table 12 shows that SUA levels were higher among male moderate smokers than among non-smokers and heavier smokers. Table 13 shows a positive relationship between coffee consumption and SUA level for males and a slight negative relationship for females. These relationships were not observed among students in the U.S. samples.

(Insert Tables 12 & 13)

Relationships between cholesterol level and class level, first term progress (as indicated by completion of all regular first term course work in the prescribed time), and ability to study under pressure were also examined among Swedish students. Among females, second year students had significantly higher cholesterol levels than first year students. There was a difference of similar magnitude for males, but first year students had the higher levels. The results are shown in Table 14. No significant results were obtained for the

other variables.

The serum chemical levels of University of Florida intercollegiate football players were higher than those of any other student group. (See Table 15.) Moreover, during football season the players SUA's and cholesterols were significantly higher than when taken during spring training.

(Insert Table 14 & 15)

Discussion

As anticipated, the analyses of the data on Swedish students revealed some marked differences in relationships between the principal variables investigated, as compared with those found with American students. Of greatest significance was the confirmation of hypothesized differences in the relationships between achievement and blood chemical values. Among the Swedes, achievement and SUA were found not to be significantly related. The significant association between cholesterol level and achievement bears further investigation, as does the relationship between these two blood chemicals.

Certain other observed differences in relationships may be due to dietary and cultural factors. For example, alcoholic drinks are used more often in European countries than in America as beverages accompanying meals; such a

difference in use may account for the lack of association between their consumption and achievement. As suggested above, differences in authoritarian and machavellian attitudes may stem from the differences between Swedish and American students' views of the role and influence of governmental and institutional systems in their lives. Differences may also be due to lack of comparability of the Swedish and American students' views of the role and influence of governmental and institutional systems in their lives. Differences may also be due to lack of comparability of the Swedish and American samples, especially since the former were psychology students and the latter were a heterogenous group. Further analyses, particularly of the biographical data, will be carried out to compare directly such characteristics of the samples.

With respect to the studies of the University of Florida football players, it would not appear that diet or amount of exercise would account for the higher SUA and cholesterol levels in the Fall football season as compared to those of the Spring training.

Summary

This study has provided further evidence indicating positive relationships between inner desire to achieve and serum uric acid level, and between external environmental pressure and cholesterol level. Among students in a highly competitive American college a significant correlation exists between SUA and GPA. This finding was not obtained with Swedish

college students where admission is more selective and academic pressure is less. Intercollegiate football players had higher SUA and cholesterol levels during the intensely pressurizing football season than in Spring training. Male science majors also had higher serum chemical levels than those with other college majors.

Examination of contrasting attitudes of American and Swedish students revealed that the latter tended to be less authoritarian, less conforming, but more machiavellian and more disenchanted.

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Table 1. Mean Chemical Values for Wagner College Students by College Class and SAT Scores

Mean	Freshmen			Sophomores		
	< 500	> 500	All	< 500	> 500	All
Uric Acid	4.61	4.20	4.43	4.70	4.52	4.61
Cholesterol	178	178	178	188	184	186
N	32	31	64	34	66	102

Mean	Juniors			Seniors		
	< 500	> 500	All	< 500	> 500	All
Uric Acid	5.01	5.15	5.05	4.53	5.52	5.05
Cholesterol	192	200	195	185	195	188
N	18	19	43	6	5	13

(Comparing Freshmen and Sophomore uric acid scores with those of Juniors and Seniors, $t = 2.8$, $p < .01$)

Table 2.

Correlation coefficients between Wagner College students' total SAT, GPA, SUA, and cholesterol, mean SAT greater than 500.

		SAT	GPA	SUA
	SAT			
	GPA	.29**		
Females	SUA	.09	.27**	
	CHOL	-.10	.18 *	.083

N = 70

* significant at .05 level

** significant at .01 level

		SAT	GPA	SUA
	SAT			
	GPA	.30**		
Males	SUA	.11	.22**	
	CHOL	.08	.05	-.02

N = 75

** significant at .01 level

Table 3.

Correlations between SUA and Cholesterol for Wagner College Students

N	Males	Females	
	75	57	79
Intercorrelations	SAT > 500	SAT < 500	SAT > 500
Uric Acid - cholesterol	-.44**	.41**	.18

** Significant at .01 level

Table 4. A Comparison of SAT Scores, Blood Chemicals, and GPA's of College Students with Different Majors

MAJOR	N	SAT (Rank)	Uric Acid (Rank)	Cholesterol (Rank)	Glucose (Rank)	GPA (Rank)
WOMEN						
Nursing	40-110	543 (2)	4.65 (1)	185 (2)	90.8 (5)	2.50 (2)
Science	8	540 (3)	4.49 (2)	189 (1)	94.5 (4)	2.46 (4)
Education	9	505 (4)	4.26 (3)	184 (3)	98.9 (2)	2.53 (1)
Social Science	8	584 (1)	3.67 (5)	184 (4)	96.3 (3)	2.47 (3)
Arts & Humanities	10	494 (5)	3.97 (4)	172 (5)	101.9 (1)	2.34 (5)
F ratio		2.51	2.47	1.04	3.06	1.22
p		.05	.05	n.s.	.025	n.s.
MEN						
Business	11	498 (5)	5.08 (3)	189 (2)	94.8 (3)	1.91 (4)
Science	20	521 (1)	5.39 (1)	193 (1)	97.1 (1)	2.36 (1)
Education	5	503 (4)	4.56 (5)	179 (5)	91.2 (5)	2.30 (2)
Social Science	11	502 (3)	4.63 (4)	185 (3)	94.1 (4)	1.78 (5)
Arts & Humanities	23	514 (2)	5.32 (2)	182 (4)	96.2 (2)	2.18 (3)
F ratio		2.97	1.01	1.63	1.23	1.48
p		.025	n.s.	n.s.	n.s.	n.s.

Table 5.

Correlation Coefficients[a] between Achievement, HSGPA, Blood Chemicals, and Attitudes - Male Swedish Students

Variable	1	2	3	4	5	6	7	8
1. HSGPA								
2. General Achievement	.10							
3. SUA	.30*	-.12						
4. Cholesterol	.15	.29*	.00					
5. Machiavellianism	.13	.15	.25	-.04				
6. Authoritarianism	.15	.05	-.01	-.32*	.30*			
7. Social Desirability	-.32	-.32*	-.08	.11	-.15	-.24		
8. Anomie	.10	-.04	-.13	.14	.43**	-.03	-.20	

[a]All coefficients in this table are based on 31 cases except those involving Achievement (25 cases) and HSGPA (29 cases). Data on these two variables were not complete.

*Significant at .05 level

**Significant at .01 level

Table 6.

Correlation Coefficients[a] Between Achievement, HSGPA, Blood Chemicals, and Attitudes - Female Swedish Students

Variable	1	2	3	4	5	6	7	8
1. HSGPA								
2. General Achievement	-.08							
3. SUA	-.12	.02						
4. Cholesterol	-.31*	.23*	-.19					
5. Machiavellianism	-.27*	.15	-.11	.16				
6. Authoritarianism	.07	.06	-.13	.09	.13			
7. Social Desirability	-.13	-.10	-.20	-.16	-.31*	-.19		
8. Anomie	-.04	-.04	-.27*	.11	.44**	.04	-.05	

[a] All correlations in this table are based on 47 cases except those involving Achievement (43 cases) and HSGPA (43 cases). Data on these two variables were incomplete.

* Significant at .05 level

** Significant at .01 level

Table 7.

Means and Standard Deviations of Achievement, HSGPA, Blood Chemicals and Attitude Measures for Male and Female Swedish Students

Variable	Males			Females		
	N	Mean	St. Dev.	N	Mean	St. Dev.
HSGPA	29	4.48	0.53	43	4.21	0.84
General Achievement	25	68.20	11.57	43	60.23	10.76
SUA	31	5.30	0.85	47	4.00	0.94
Cholesterol	31	207.13	29.67	47	192.72	26.49
Machiavellianism	31	100.52	13.26	47	99.77	9.86
Authoritarianism	31	60.87	12.45	47	59.40	11.83
Social Desirability	31	9.55	1.71	47	10.11	1.82
Anomie	31	30.87	5.89	47	32.04	7.84

Table 8.

Mean SUA and Cholesterol Levels of Swedish and American Wagner College Students, by Sex.

Chemical	Females		Males	
	Swedish	American	Swedish	American
	N = 47	N = 79	N = 31	N = 73
SUA	4.00	4.49 ($t = 2.4$, $p < .02$)	5.30	5.20 (not significant)
Cholesterol	192.72	184.00 ($t = 2.0$, $p < .05$)	207.13	186.00 ($t = 3.2$, $p < .01$)

Table 9.

Mean Attitude Scores of Swedish and American Wagner College Students, by Sex

Attitude	Females		Males	
	Swedish N=47	American[a] N=196	Swedish N=31	American[a] N=186
Authoritarianism	59.4	68.0	60.9	69.7
Social Desirability	10.1	14.9	9.6	13.8
Anomie	32.0	25.1	30.9	27.0
Michiavellianism	99.8	70.5	100.5	74.7

[a] Freshmen students at Wagner College, class of 1968

Table 10.

Mean General Achievement for Groups Differing in Amount of Coffee Consumption, Male and Female Swedish Students

	Achievement	
Coffee Consumption	Males	Females
Two cups or less per day	72.3 (N=15)	61.9 (N=17)
Three or more cups per day	62.0 (N=10)	59.1 (N=26)

Main effect of coffee consumption significant at .05 level (F= 5.71)

Table 11

Mean General Achievement for Groups Differing in Amount of Physical Exercise, Male and Female Swedish Student

Amount of Exercise	Achievement			
	Male		Female	
None	73.0	(N = 10)	57.5	(N = 14)
1 or 2 hours per week	68.3	(N = 8)	61.3	(N = 15)
3 or more hours per week	66.0	(N = 10)	61.5	(N = 14)

Interaction significant at .05 level (F = 4.09)

Table 12.

Mean SUA Levels for Groups Differing in Amount of Smoking, Male and Female Swedish Students

Amount of Smoking	SUA Level	
	Males	Females
None	5.1 (N = 14)	4.1 (N = 21)
Less than one pack per week	6.0 (N = 8)	3.8 (N = 11)
One-half pack or more per day	5.0 (N = 9)	4.1 (N = 15)

Interaction significant at .05 level (F = 3.66).

Table 13.

Mean SUA Levels for Groups Differing in Amount of Coffee Consumption, Male and Female Swedish Students

Amount of Coffee Consumption	SUA Level	
	Males	Females
Two cups or less per day	5.1 (N = 19)	4.2 (N = 19)
Three or more cups per day	5.7 (N = 12)	3.9 (N = 28)

Interaction significant at .05 level. (F = 4.33)

Table 14.

Mean Cholesterol Levels for Groups Differing in Class Level (First or Second Year), Male and Female Swedish Student

	Cholesterol Level	
Class Level	Males	Females
First Year	211.5 (N = 22)	185.0 (N = 27)
Second Year	196.4 (N = 9)	203.2 (N = 20)

Interaction significant at .05 level (F = 6.30).

Table 15.

Mean Serum Chemical Levels of University of Florida Intercollegiate Football Players during Football Season and in Spring Practice

	Spring N=87	Fall N=138
SUA	5.85	6.64
	(t=4.1, p < .01)	
Cholesterol	193.83	245.57
	(t=2.7, p < .01)	